

SPADE[®]

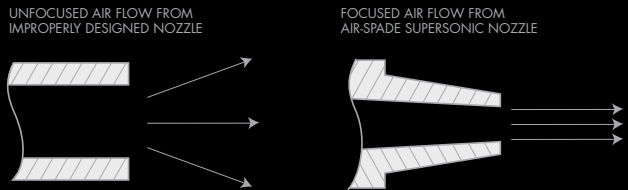


**FREQUENTLY ASKED
TECHNICAL QUESTIONS**

HOW DOES AIR-SPADE WORK?

The patented supersonic nozzle in the AIR-SPADE turns compressed air into a high speed, laser-like jet moving at twice the speed of sound; Mach 2. All of the energy and momentum of this air moving at approximately 1200 mph is focused onto the soil, dislodging it in a fraction of a second.

Soil is an unconsolidated assemblage of solid particles that may or may not contain organic matter. The voids between the particles are occupied by air and/or water. The aggregate nature of soil aids the ability of the air to fracture it; while stronger materials and ones that are not porous like metal or plastic pipes, cables, or even wooden tree roots are unaffected.



HOW DOES AIR-SPADE OUTPERFORM OTHER AIR TOOLS?

In head to head tests, the AIR-SPADE dislodged harder clay soil and dug faster than other air digging tools. Soil fractures from compressive stress, tons per square foot (tsf), exerted on its surface. As shown above for the same pressure and flow, compressed air exiting from an improperly designed nozzle expands outward rapidly to 3 to 4 times the area versus the jet from the patented supersonic nozzle in the AIR-SPADE.

WILL HIGHER PRESSURE MAKE THE AIR-SPADE WORK BETTER?

All AIR-SPADE nozzles are developed to operate optimally at 90 psig. Supplying higher pressure to a supersonic nozzle that has been optimized for 90 psig actually defocuses the air jet, thus degrading performance while consuming more air. For example, doubling the air pressure to 180 psig increases the air jet force by only 10% and the exit momentum flux (stress seen by the soil) by only 45%. Supplying higher pressure to a nozzle designed to work at 90 psig actually un-focuses the air jet degrading performance while consuming more air.

IN WHAT TYPES OF SOIL WILL AN AIR-SPADE WORK?

Because of its unique, focused air-jet, the AIR-SPADE works in most soils, even hard clays. Cohesive soils can be classified and described by unconfined compressive strength as shown in the chart to the right. Tests have shown the AIR-SPADE to be effective in compacted soils with unconfined compressive strengths, well above the values listed for hard clay.

Watering the work area ahead of time can sometimes be helpful. Water reduces most airborne dust if the soil is extremely dry. It also reduces the soil's strength making it easier to dig. Combining the use of the AIR-SPADE with a low pressure water jet is effective even with extreme cases of highly compacted or sun-baked soils.

The AIR-SPADE in general will not cut through rock. Shales, however, may be broken apart by the AIR-SPADE if the jet is directed between the laminations of the rock. Similarly, the AIR-SPADE will not dislodge hard frozen soil which may behave like pavement or concrete.

Strength of Clays

Consistency	Unconfined Compression Strength (tsf)
Very Soft	0 to 0.25
Soft	0.25 to 0.5
Medium	0.5 to 1
Stiff	1 to 2
Very Stiff	2 to 4
Hard	> 4

HOW SHOULD I DIG WITH THE AIR-SPADE?

The AIR-SPADE will dislodge up to several inches deep in a medium to stiff soil. Unless the soil is highly compacted, dwelling on the same spot is unnecessary and tends to increase spray. The AIR-SPADE can be moved over the soil surface at a rate of about 1 to 2 feet per second. When several inches of soil have been loosened, the soil should be removed to expose a fresh working face for the air jet. Vacuum suction, as provided by our AIR-VAC unit, is an excellent companion to the AIR-SPADE since it is likewise non-damaging.

OSHA Cohesive Soil Classifications

OSHA Type	Unconfined Compressive Strength	Description Cohesive soils including:
A	≥ 1.5 tsf	Clay, silty clay, sandy clay, clay loam, caliche, hardpan, and sometimes silty clay loam and sandy clay loam.
B	< 1.5 and > 0.5 tsf	Granular cohesive soils like angular gravel, silt, silt loam, sandy loam, and sometimes silty clay loam and sandy clay loam.
C	≤ 0.5 tsf	Granular soils such as gravel, sand, loamy sand, submerged soil, or soil from which water is freely seeping.

WHAT SIZE AIR-SPADE NOZZLE SHOULD I USE?

This depends on the desired rate of soil excavation which is in turn dependent upon the air delivered from the AIR-SPADE nozzle. Rates are summarized in the table below:

Soil Excavation Rates

Nozzle Size (scfm)	Soil Excavation Rates (cubic ft / min)
25	0.4 to 0.9
60	0.7 to 1.1
105	0.9 to 1.5
150	1.2 to 1.8
225	1.7 to 2.3

WHAT SIZE AIR HOSE DO I NEED FOR THE AIR-SPADE?

Compressed air flowing through a hose experiences a drop in pressure from friction and constrictions. Friction loss is proportional to the length of the hose. The amount of air, its pressure, the hose inner diameter and its smoothness also determines the loss. The table below shows the pressure loss for 50 feet of common air hose with couplings as a function of size and nozzle flow, cfm, for air at a pressure of 90 psig. Generally, a 1-inch air hose is recommended for use with the AIR-SPADE.

Pressure Loss (psig) for 50 feet of common air hose

		Flow	(cfm)		
Hose ID	25	60	105	150	225
3/4"	0.3	1.6	5.6	12.3	25.0
1"	0.1	0.4	1.3	2.8	5.5
1 1/4"	0.0	0.1	0.4	0.8	2.0

The AIR-VAC makes a perfect companion to the AIR-SPADE for a complete air-vacuum excavation system.

WHAT SIZE AIR COMPRESSOR DO I NEED TO USE THE AIR-SPADE PROPERLY?

Portable air compressors have model numbers that are normally sized by the approximate air delivery in standard cubic feet per minute (scfm) at a gauge delivery pressure of 100 pounds per square inch (psig). For example, a 185 compressor will deliver 185 scfm at 100 psig. All AIR-SPADE nozzles are rated at 90 psig and are designated by their air delivery at this pressure. Five nozzles are available to cover the size range of most portable air compressors. To size an AIR-SPADE nozzle to a compressor simply ensure the compressor size is larger than the nozzle size. The below table lists the minimum portable air compressor size needed to properly run a given AIR-SPADE nozzle. Note, a smaller nozzle may always be used on a larger compressor, but not the reverse. Trying to run a larger nozzle on a smaller compressor will result in significantly less than 90 psig being delivered and will noticeably diminish performance.

Recommended Compressor Size

Nozzle Size (scfm)	Minimum Compressor Size (scfm @ 100 psig)
25	25
60	60
105	125
150	175
225	250

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